Space Weather Technical Forecast

Issued on Thursday, 23 June 2022 at 13:21 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of an isolated M-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has remained Low over the past 24 hours, with occasional C-class flares becoming more isolated with time, while the background level of X-ray flux at GOES16 declined further into B-class. This activity peaked with a long-period C4.0 flare from the southwestern horizon at the end of the 24-hour reporting period, with the source not visible from an Earth-based perspective.

There remain issues with the range and cadence of available satellite imagery at present, however there appear to be four sunspots on the visible disc. By far the largest and nominally the most complex remains AR2038, which manifests as Eki/Beta-Gamma, with a slight spreading trend evident. Its intermediate spots generally faded in the first half of the period, with a slight reversal in this tendency as the 24-hour period ended. Otherwise, the main changes in current sunspot groups were to 3034 in the southwest, which saw significant trailer decay to end as a Cso/Beta. Rounding off the front side population, AR3035 was an unchanged Hsx/Alpha, while AR3040 also remained stable as a Dso/Beta in the southeast.

Analysis of front side potential Coronal Mass Ejection (CME)-causing events has been somewhat hampered in the past 24 hours, however there were a few disappearing filaments and prominences observed. These included a dimming observable in SUVI195 imagery around the turn of the UTC day in the southern solar hemisphere near the meridian. There is not as yet any sign of any Earth-bound CME from this event on coronagraphs, however this is one of the main aspects of monitoring.

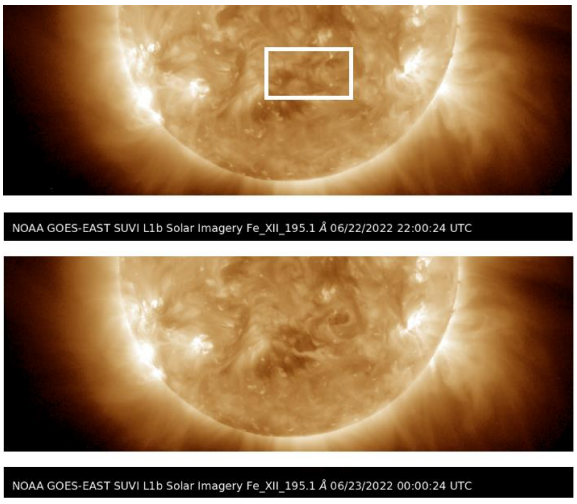
NOAA GOES-EAST SUVI L1b Solar Imagery Fe_XII_195.1 Å 06/22/2022 22:00:24 UTC
NOAA GOES-EAST SUVI L1b Solar Imagery Fe_XII_195.1 Å 06/23/2022 00:00:24 UTC

Figure 0: SUVI 195 imagery of near centre-disc dimming. There is no obvious link with ejecta seen on resultant coronagraph imagery, however this is being monitored.

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Other events included: a disappearing filament from the northeast quadrant at 22/1330UTC; a prominence from the southwest at 22/1600UTC; a near-western horizon filament at 22/1900UTC; a southeastern prominence at 23/0430UTC, and the aforementioned C4.0-flare tied southwest limb event to end the 24 hours.

Coronagraph imagery for the period hints at a front-sided high latitude event that lies off the ecliptic, with all other visible candidates generally well limb-ward to no presumed effect at Earth. Should thoughts on this change or more imagery become available, more thorough analyses will be conducted.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR and ACE at L1, was slightly elevated in the past 24 hours, with the solar wind speed varying between 400 and 500km/s, with a slightly different character according to which of the two L1 satellites is referenced - DSCOVR with a more obvious downward trend after an erratic rise between 22/2100-2400UTC; ACE with a more level trend. The solar wind density was similarly slightly elevated in low double figures ppcc, while the IMF showed an early peak near 9nT, with the north-south component varying between +/-6nT. The phi angle was negative (towards the sun).
Overall, the above measures may be reflective of a SSBC that preceded the 24-hour time window, with current solar wind measures now approaching a slow solar wind regime, but with the rising density perhaps hinting at an impending CIR - with CH93/- the expected source from the forecast.

The net result of the above solar wind measures was provisionally Quiet to Unsettled geomagnetic activity, with two successive intervals of Kp '3o' recorded 00-03 and 03-06UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured by GOES16 remained at background levels through the period.

High energy electron flux (greater than 2MeV) peaked at High levels in the period but generally reduced in amplitude with time, with 1178pfu observed at GOES16 at 22/1550UTC. The corresponding 24-hour integrated electron fluence mirrored the declining trend, remaining below the Active threshold (1e8 integrated pfu), and with an observed fluence of 4.87e7 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low, with a daily Chance of an isolated M-class flare. AR3038 dominates the disc in terms of flare risk and should remain on the front side throughout, while there are no forecast returning regions over the eastern limb.

Solar Wind / Geomagnetic Activity: No CMEs currently feature in the forecast.

Geomagnetic activity should be most reliably quiet at the very start and end of the current four-day period, with Earth expected to transit into the high speed stream(s) emanating from negative polarity coronal holes in the interim, of which CH95/- should be most marked, probably on day three, Saturday 25 June. There is a Slight Chance at peak of G1 conditions, although being near the solstice these effects ought to be somewhat muted.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) is expected to be at Background levels during the period, but with a daily Slight Chance of an S1 or greater event as a result of the nominally complex AR3038 gradually nearing the western limb.

The high energy electron flux (greater than 2 MeV) should show an eventual rising trend in the four days, perhaps in a step-wise fashion in response to a series of negative polarity coronal

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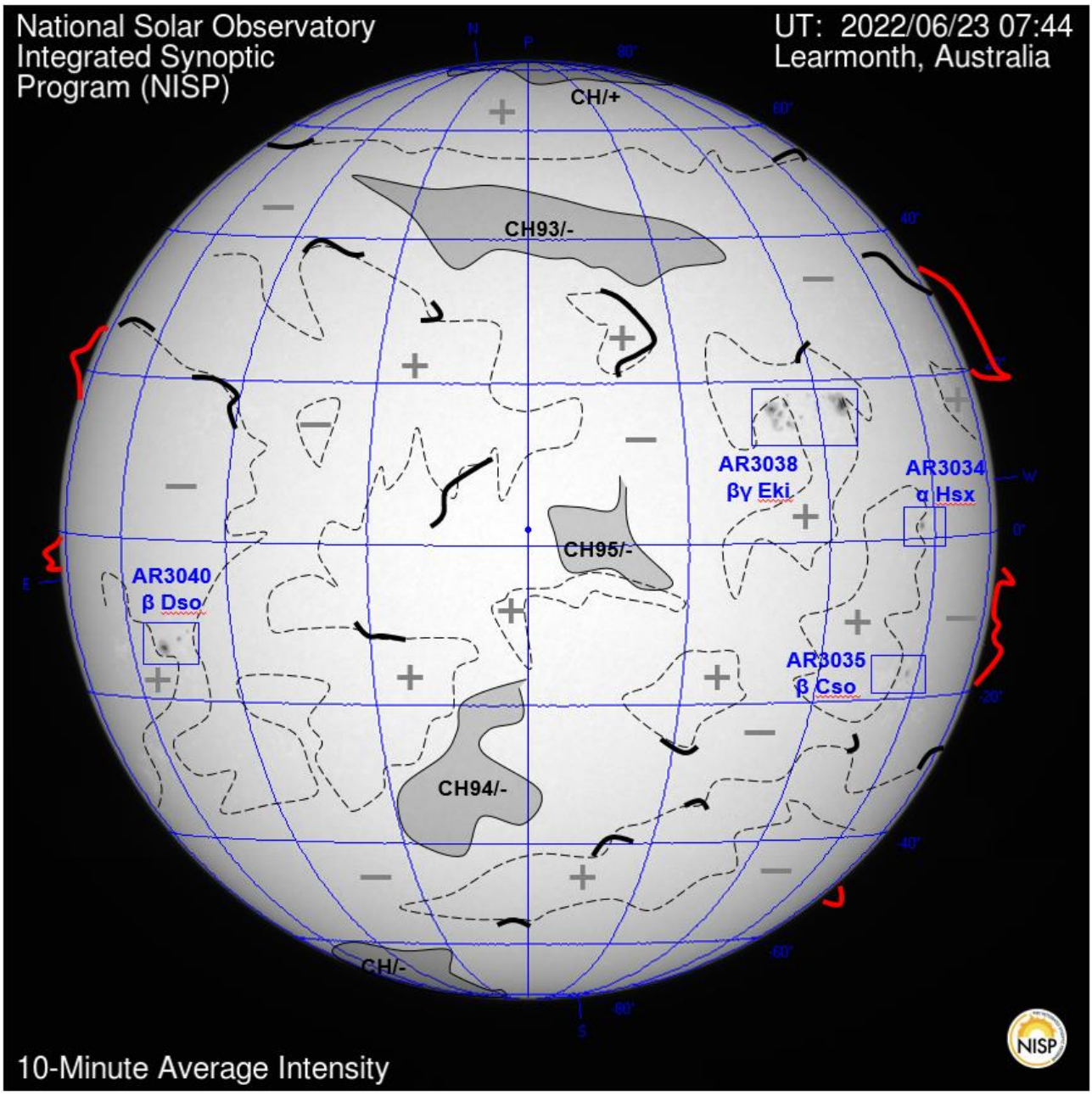
holes in turn. This will most likely stabilise at below-Active 24-hour integrated fluence at the end of the coming UTC weekend, although confidence is lowered by differences in the geometry of the driving coronal hole fast winds.

Figure 1. Solar Analysis Valid 23/0500UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in the forecast. Confidence in this remaining the case is lower than is typical given numerous disappearing filaments in the past 24 hours and the lower availability of confirmatory imagery.

STEREO A MAG and PLASTIC data are currently hinting at an arriving disturbance in the past few hours, which is either a sizeable CIR or else a CME, with the IMF in the high teens of nT. The phi angle is the pre-requisite negative at both Earth and STEREO A, so the former is perhaps the preferred explanation, perhaps CH95/-. There are up to three negative polarity coronal holes that may feature to some degree in the coming four days, and distinguishing between them is likely to be difficult - on paper CH95/- looks the most potent. It should also be said that the current geometry of these holes bears little resemblance to last pass, and as such confidence is lower than is typical, with the muting effect of the solstice the main rationale for the rather low G1 risk through the four days.

Depending on the nature of the disturbance at STEREO A (which will become clearer with time), geomagnetic activity should perhaps be most reliably quiet at the start and very end of the current four-day period, with Earth expected to transit into the high speed stream emanating from negative polarity coronal holes in the interim, with CH95/- probably the main feature of note, with a most likely arrival of day three, Saturday 25 June. There is a Slight Chance at peak of G1 conditions, although being near the solstice these effects ought to be somewhat muted.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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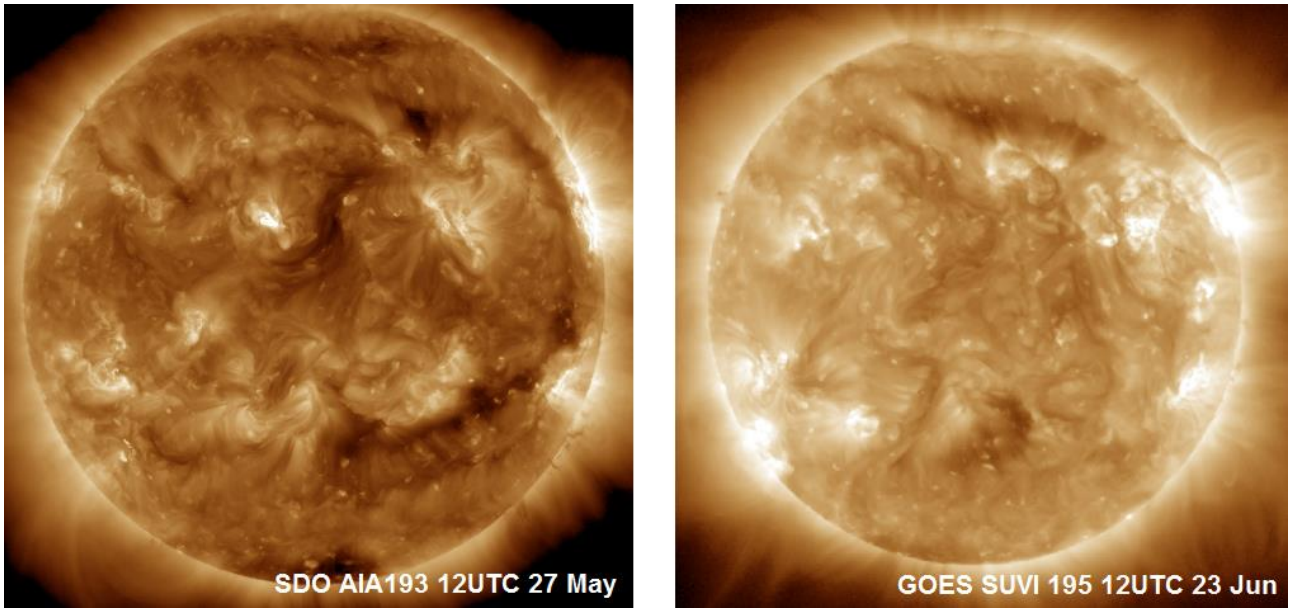
Figure 2: Coronal hole configuration for the current time (right, 195A wavelength) and 27 days prior (left, 193A). Despite differences in the observed wavelength and processing, the discrepancies between expected coronal holes (especially CH95/-, centre top) can be seen, lowering confidence in persistince methods.



Radio Blackouts - X-Ray Flares:

There are currently up to four sunspot regions on the solar disc. By far the most complex in terms of Zurich/Mt Wilson classification remains AR3038, which showed an overall decrease in area in the period but still finished as a complex 14 degree solar longitude-spanning Eki/Beta-Gamma. This spot continues to run counter to expectations in being relatively quiescent for its class, however given its complexity and some observed mobility in its intermediate portions, it could still spark into life, being the rationale for the majority of the flat 25% daily risk of M-class activity.

All other spots were unremarkable in the past 24 hours, with AR3040 in particular showing decay. In terms of the balance of groups, none of the main contributors to risk depart the disc in the four days, and there are no returning or newly-developed regions due over the eastern limb from persistence and the past 2 days' STEREO imagery.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	5	5	5	5

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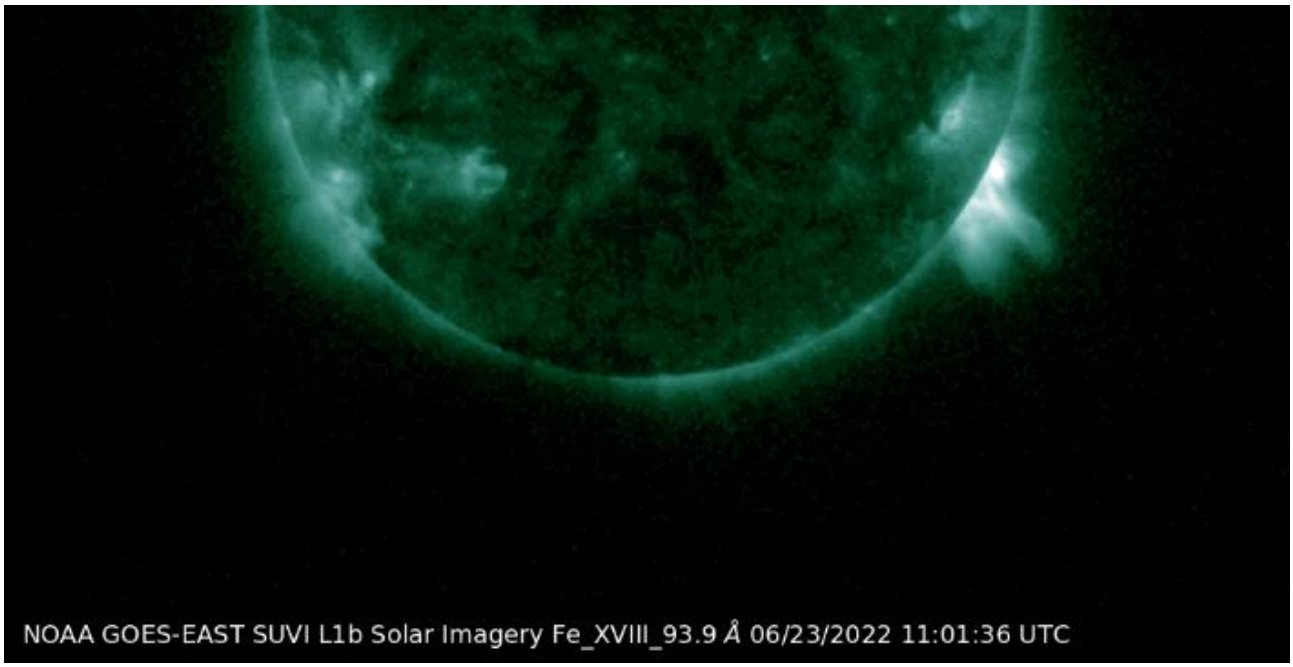
Figure 3: SUVI 94 imagery of the aftermath of the long-period peak X-ray flare from the southwestern limb. The source is uncertain, although any resultant CME is unlikely to have an Earth-bound compoent for being both too far west and below the ecliptic plane.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels, and will most likely remain at this level through the period given the observed lack of activity from the main sunspot on the disc, AR3038.

There is a nominal slightly increasing chance of an S1 or greater event through the next four days as AR3038 progresses ever-westwards, although this rising risk is not significantly different from the illustrated flat 5% through the four days. In addition, this region has been somewhat more subdued than its Zurich class implies, with no recent history of proton events.

Radiation Storms Probability (Exceedance)	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC) (%)**	**Day 2 (00-24 UTC) (%)**	**Day 3 (00-24 UTC) (%)**	**Day 4 (00-24 UTC) (%)**
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) should show an eventual rising trend in the four days, perhaps in a step-wise fashion in response to a series of negative polarity coronal holes in turn. This will most likely stabilise at below-Active 24-hour integrated fluence at the end of the coming UTC weekend, although confidence is lowered by differences in the geometry of the driving coronal hole fast winds.

MOSWOC REFM's current 72-hour forecast is tentatively accepted as good guidance, with the caveat that the upcoming coronal holes appear much-changed, and any eventual uptick in fluence probably exceeds the model's range (into day four).

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	5	10	20	40
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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